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UNION CARBIDE

INTERNAL CORRESPONDENCE

NUCLEAR DIVISION

POST OFFICE BOX Y, OAK RIDGE, TENNESSEE 37830

To (Name) Mr. G. B. Marrow
Division
Location

Date July 7, 1972

Originating Dept.

Answering letter date

Y-12

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Subject Environmental Nitrate Sampling Program

The results of the June nitrate sampling program for Poplar Creek sampled near Building 9720-5 storm sewer outfall, and upper Bear Creek Valley 0.3 mile below the S-3 disposal ponds are presented in the attached Tables I and II. A few soluble uranium analyses for Bear Creek and Poplar Creek are also included. It appears from the data that the uranium content is closely related to the nitrate concentration in Bear Creek, both ions fluctuating in response to dry periods and rainfall. Some buildup of contaminants in the ground water was apparent during dry periods. This accumulation was usually flushed at the first heavy rain resulting in increased mass flow of nitrates in both creeks.

A summary by months of the total nitrates at the two sampling locations is presented in Table III. S-3 acid disposal pond water elevations from July, 1971 to July, 1972 are given in Table IV. On an annual basis the water levels in the four ponds have remained at about the same elevations, indicating a hydraulic balance between receipts of acidic effluents and rainfall versus losses by evaporation and seepage. Acidic effluents pumped to the S-3 disposal ponds are currently running about one-third higher than the volume pumped in previous years. Maintenance of the present hydraulic balance will, therefore, probably result in an increase of the contaminants being discharged to the environment.

Ground water samples were obtained on June 16, 1972 from four, 10-foot deep wells located 100 to 1,000 feet in an easterly direction from the S-3 disposal ponds and inside the Y-12 west perimeter fence. Each well was pumped dry on the previous day to insure a fresh flow of ground water into the well. Ground water elevations in wells 2, 3 and 5, Table V, appear to be lower due to a storm drainage system that intersects the area. It is evident that most of the nitrate contaminated ground water was also intercepted by the storm drainage system, since low nitrate values were found in wells 3 and 5, located on the low side of the storm drain. Previous nitrate analyses for the same wells on July 14, 1971 and August 30, 1971 are compared with current analyses, Table VI.

#784

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Streams in the vicinity of the S-3 ponds and upper Bear Creek were sampled on June 26, 1972 after 36 days of relatively low rainfall (1.96 inches). The maximum nitrate and uranium concentrations were found at the weir station, established approximately 0.3-mile west of the S-3 acid ponds, where the nitrate was 13,837 μg/ml and soluble uranium 43.5 μg/g, Table VII. Although these analyses were high, the volume of water flowing was low and ultimately dilution water contributed from side streams containing lesser amounts of nitrate and uranium had a cumulative effect in lowering the overall contamination levels. This dilution also raised the pH to a level high enough to precipitate most of the aluminum and uranium ions, Table VII. These precipitates are carried downstream during high water, eventually accumulating with other sediments in lower Bear Creek and, possibly, in the Watts Bar embayment.

Both the north and the west branches of upper Bear Creek contribute nitrates at elevations below the 970-foot contour line. This is due to a number of shallow aquifers which are contaminated by seepage water from the S-3 ponds. Their flow tends to keep the ground water and the branches to the west of the S-3 ponds charged with varying amounts of nitrates. Upper Bear Creek water leaving the area at approximately 0.8-mile west of the S-3 ponds contained 800 to 1,950 μg/ml nitrates depending on flow conditions. Bear Creek then flows on a course parallel and within 100 feet of the Y-12 sanitary landfill excavation. The bottom of the landfill pit is 9.2 feet lower than the creek bed. Seepage of nitrates into the landfill pit was not apparent after several analyses, indicating that the shale and soil porosity in the dyke is low. The landfill entrance gate is approximately 1.2 miles west of the S-3 ponds.

Proceeding downstream from the landfill site, approximately 0.3-mile, an outcrop of the shale formation in Bear Creek exhibits a somewhat fractured condition. In this general area the creek flow disappeared underground and the creek bed remained dry for a distance of approximately 0.2-mile, where the flow again resumed due to contributions from spring number 2. It appears that some of the lost flow from Bear Creek may be reappearing at downstream springs numbers 2, 3 and 4. Considerable dilution is indicated, however, by the analyses, Table VII. This fortunate circumstance minimizes the downstream nitrate content, particularly during dry weather when upper Bear Creek is at its maximum concentrations. There appears to be a built-in underground storage capacity that operates to hold back nitrates when they are at a maximum and the stream flow is at a minimum, but functions to release stored nitrates during increased creek and ground water activity.

The first phase of a forest fertilization experiment being conducted in cooperation with the ORNL Ecology Division was completed on June 27, 1972 following irrigation of 12 plots of hardwood forest land located on a ridge on the north side of Bear Creek Road. Initial spreading rates were 88 to 266 pounds of nitrates per acre. The source of the nitrate was raw water collected in upper Bear Creek

at the weir site which contained 12,500 µg/g nitrate and 37 µg/g uranium. Lime hydrate was an effective precipitant and coagulant for the uranium and aluminum, producing a relatively pure calcium nitrate solution for the fertilization experiment. Further applications will be added until spreading rates of 200, 500 and 800 pounds per acre are attained.

Mr. Frank W. Harris of the Environmental Sciences Division, ORNL, has completed the initial phase of the sampling program for use in evaluating the effect of nitrate spreading on the forest ecosystems. This work includes periodic collection of soil, water and foliage samples which will be analyzed and compared to determine the bioaccumulation of significant elements and an evaluation of the forest landscape to absorb neutralized effluent materials.

H C Francke

H. C. Francke

HCF:wj

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TABLE I

POPLAR CREEK NITRATES - AT STORM SEWER OUTFALL NEAR 9720-5

June 1972	Y-12 Rainfall (Inches)	pH At Outfall	Flow (gpm)	Flow (10^6 lbs/day)	Nitrates (µg/ml)	Nitrates (lbs/day)	Uranium (µg/g)
1	-	6.7	700	8.4	52	437	0.01
2	-	6.5	620	7.4	89	659	-
3	-	6.5	620	7.4	51	377	-
4	-	6.7	660	7.9	51	403	-
5	-	7.6	660	7.9	52	411	-
6	0.32	7.8	800	9.6	41	394	-
7	-	6.7	860	10.3	44	453	0.02
8	-	6.7	860	10.3	39	402	-
9	0.18	6.9	800	9.6	43	413	-
10	0.11	7.3	700	8.4	55	462	-
11	-	7.6	585	7.0	57	399	0.02
12	-	7.3	585	7.0	54	378	-
13	-	7.8	620	7.4	63	466	-
14	-	7.5	585	7.0	53	371	-
15	-	7.0	585	7.0	55	385	-
16	0.21	7.6	860	10.3	88	906	-
17	0.15	7.1	1,060	12.7	59	749	-
18	0.24	7.0	700	8.4	59	496	-
19	-	7.8	620	7.4	56	414	-
20	0.51	7.1	1,060	12.7	113	1,435	-
21	-	7.2	860	10.3	53	546	-
22	-	7.1	700	8.4	55	462	-
23	-	7.0	700	8.4	47	395	-
24	-	7.0	700	8.4	54	454	-
25	-	7.2	700	8.4	45	378	-
26	-	7.2	700	8.4	45	378	-
27	-	7.4	700	8.4	52	437	-
28	2.28	7.3	5,000	60.0	18	1,080	0.64
29	0.03	6.9	900	10.8	67	724	-
30	-	7.3	775	9.3	47	437	-
Totals	4.03					15,701	

TABLE II

BEAR CREEK NITRATES - 0.3 MILE WEST OF S-3 PONDS

June	Y-12 Rainfall (Inches)	pH At Weir	Depth (Inches)	Flow (gpm)	Nitrates (µg/ml)	Nitrates (lbs/day)	Uranium (µg/g)	Uranium (lbs/day)
1	-	3.7	1.3	5.0	7,292	438	-	-
2	-	3.7	1.3	5.0	8,266	496	21.9	1.31
3	-	3.7	1.3	5.0	7,770	466	-	-
4	-	3.7	1.3	5.0	8,267	496	-	-
5	-	3.9	1.2	4.0	8,579	411	-	-
6	0.32	3.9	1.1	3.0	8,947	322	-	-
7	-	3.7	1.1	3.0	9,591	345	34.0	1.22
8	-	3.7	1.2	4.0	9,554	459	33.0	1.58
9	0.18	3.7	1.1	3.0	9,793	353	-	-
10	0.11	3.6	1.2	4.0	10,310	495	-	-
11	-	3.6	1.0	2.6	10,816	337	-	-
12	-	3.7	1.0	2.6	11,092	346	-	-
13	-	3.8	0.9	2.0	11,687	280	40.9	0.98
14	-	3.9	0.9	2.0	11,885	285	-	-
15	-	3.5	0.8	1.6	12,115	233	-	-
16	0.21	3.9	1.0	2.6	13,448	420	45.2	1.41
17	0.15	3.5	1.1	3.0	12,943	466	-	-
18	0.24	3.5	0.8	1.6	11,969	230	46.3	0.89
19	-	4.0	0.8	1.6	13,356	256	-	-
20	0.51	4.0	1.3	5.0	10,008	601	40.0	2.40
21	-	3.9	0.8	1.6	12,000	230	44.3	-
22	-	4.4	0.8	1.6	12,460	239	27.8	0.53
23	-	3.7	0.8	1.6	13,808	265	-	-
24	-	3.7	0.6	0.8	13,807	133	37.5	0.36
25	-	3.6	0.6	0.8	14,144	136	43.5	0.42
26	-	3.7	0.5	0.4	13,837	66	-	-
27	-	3.6	0.5	0.4	14,757	71	44.9	0.22
28	2.28	3.7	2.0	12.0	5,126	738	18.0	0.26
29	0.03	5.6	6.0	196.0	612	1,471	-	-
30	-	4.0	3.6	54.0	2,331	1,510	-	-
Totals	4.03					12,534		

TABLE III

TOTAL NITRATES BY MONTHS IN BEAR CREEK AND POPLAR CREEK

Month	Rainfall	Total Lbs. NO_3	
		Poplar Creek	Bear Creek
July	8.76	11,000 (Est.)	13,257
August	2.36	10,517	18,672
September	2.84	9,189	4,166
October	2.01	11,113	4,687
November	1.94	14,694	5,363
December	6.12	11,460	19,053
January	7.15	16,909	29,120
February	4.77	14,379	31,432
March	6.02	18,456	36,272
April	2.99	15,284	30,964
May	5.15	14,984	22,947
June	4.03	15,701	12,534

TABLE IV

S-3 DISPOSAL POND SOLUTION ELEVATIONS BY MONTHS

Date	Pond (Elevation-Feet)			
	NE	SE	NW	SW
July 21, 1971	1013.8	1011.7	1013.3	1011.2
August 12, 1971	1014.0	1011.9	1013.7	1011.5
September 3, 1971	1013.6	1011.4	1012.7	1011.0
October 12, 1971	1013.8	1011.3	1012.2	1010.5
November 9, 1971	1013.8	1011.1	1012.0	1010.2
December 14, 1971	1013.8	1011.0	1012.6	1010.3
January 7, 1972	1013.9	1011.5	1013.6	1010.8
February 10, 1972	1013.8	1011.7	1013.8	1011.2
March 8, 1972	1014.4	1012.0	1014.2	1011.7
April 4, 1972	1014.4	1012.0	1014.2	1012.0
May 2, 1972	1013.8	1012.0	1013.8	1012.0
June 5, 1972	1013.7	1011.7	1013.7	1012.2
July 5, 1972	1013.9	1011.4	1013.5	1011.7

TABLE V

NITRATE AND URANIUM ANALYSES - GROUND WATER IN

WEST END OF Y-12 PLANT

Well No.(1)	Distance S-3 Ponds (ft.)	Depth To Water (inches)	pH	Nitrate (µg/ml)	Uranium (µg/ml)
1	150 East	32	6.69	806	< 0.01
2	250 Southeast	Dry	-	-	-
3	400 East	72	7.69	3	0.03
4	350 East	21	6.82	25	0.30
5	1,000 East	47	7.37	1.5	0.05

(1) Sampled June 16, 1972 following 25 days with only 0.84 inches cumulative rainfall. Wells were pumped dry the previous day. All are located inside Y-12 perimeter fence.

TABLE VI

NITRATE CONTENT OF GROUND WATER

IN WEST END OF Y-12 PLANT

AT DIFFERENT SAMPLING DATES

Well No.	July 14 1971	August 30 1971	June 16 1972
1	408	357	806
2	303	Dry	Dry
3	2	< 0.4	3
4	60	< 0.4	25.
5	1	< 0.4	1.5

TABLE VII

NITRATE AND URANIUM ANALYSES - IN UPPER BEAR CREEK AREA

Location of Sample[1]	Distance To S-3 Ponds (~ mi.)	pH	NO_3 (µg/ml)	U (µg/g)
Bear Creek, At Weir Station	0.3	3.70	13,837	43.5
Bear Creek, Spring "0"	0.7	6.71	160	0.06
Bear Creek Road, Wye Culvert	0.75	4.39	1885	3.0
Bear Creek, West Branch Near Culvert	0.7	7.75	1060	< 0.01
Bear Creek, West Branch ~ 400' To Road	0.6	7.41	263	< 0.01
Bear Creek, West Branch ~ 600' To Road	0.65	7.41	1.2	< 0.01
Bear Creek, West Branch TVA - ROW	0.7	7.35	1.4	< 0.01
Bear Creek, North Branch, Culvert	0.3	7.60	1.7	< 0.01
Landfill Excavation, Pit Water	1.1	6.39	1.6	0.06
Bear Creek, Landfill Entrance	1.2	6.80	786	0.22
Bear Creek, Fractured Shale Formation	1.5	DRY CREEK BED		
Bear Creek, Spring No. 2	1.7	7.2	135	0.16
Bear Creek, West Gate Burial Ground	2.0	7.30	156	0.34
Bear Creek, Main Stream Below Bridge	2.4	7.84	103	0.19

[1] All samples were collected on 6-26-72 following a 36-day period with a cumulative rainfall of 1.96 inches.

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OAK RIDGE Y-12 PLANT INFORMATION CONTROL FORM

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UNION CARBIDE

INTERNAL CORRESPONDENCE

NUCLEAR DIVISION

POST OFFICE BOX Y, OAK RIDGE, TENNESSEE 37830

To (Name) Mr. J. M. Napier

Division

Location

Date August 8, 1972

Originating Dept.

Answering letter date

4-12

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Subject Environmental Nitrate Sampling Program

The results of the July nitrate sampling program for Poplar Creek sampled near Building 9720-5 storm sewer outfall, and upper Bear Creek Valley 0.3 mile below the S-3 disposal ponds are presented in the attached Tables I and II. Soluble uranium analyses for Bear Creek and Poplar Creek are included.

A summary by months of the total nitrates at the two sampling locations is presented in Table III. S-3 acid disposal pond water elevations from August, 1971 to August, 1972 are given in Table IV.

Analytical results on a series of samples from upper Bear Creek and two of its tributary streams are reported in Table V. The first six samples were collected after 2.31 inches of rainfall occurring within a 24-hour period. They indicate a significant dilution effect from rainwater runoff. Surface waters from the upper reaches of the North and West Branches of Bear Creek, Table VI, and other side streams were sufficient to dilute the maximum nitrate concentration found from 14,700 to less than 1,000 µg/ml, and to raise the pH from 3.6 to 6.8 by the time the mixed waters in Bear Creek had moved to the sanitary landfill area. When dry weather resumed, the runoff diminished, and again the pH dropped and the nitrate concentration rose as shown by the July 3, 1972 analyses. An excavated pool, immediately downstream of the weir station, 0.3-mile due west of the S-3 ponds, serves to reduce the flow of high nitrate solutions during periods of dry weather. Evaporation and seepage from this pool appear to be sufficient to reduce any overflow out of the pool except when high input flows prevail in rainy weather. When heavy rainfall occurs, the nitrate rich impounded water in the pool is displaced by nitrate free surface waters which flush out the pool and dispose of the high nitrate at much lower concentrations. If a sufficiently large lake or pond could be created

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downstream of all the nitrate contributing streams, it appears that much of the impounded water in dry weather could be evaporated or forced into ground water aquifers where neutralization and precipitation would naturally occur. The impoundment would have to be large enough to provide watershed storage of sufficient capacity to hold a backlog of at least one-inch of rainfall before overflowing.

A sample taken on July 24th, Table V, following four days of dry weather, Table II, indicates that Bear Creek water as far as the west burial ground gate contained more than 1,000 μg/ml nitrate and had a pH of 5.3. On July 26th, after 1.38 inches of rainfall on July 25th, the nitrate at this location had dropped to 650 μg/ml with a pH of 6.3. Further downstream dilution from spring number 3 serves to bring the pH up to 8.0, also removing all but traces of soluble uranium.

The sample taken at the outlet of the North Branch of Bear Creek on July 27th is indicative of the nitrate contribution from surfacing aquifers along this stream bed from the time it flows through the Bear Creek Road culvert. At the culvert the water content is usually 1 to 4 μg/ml. On the date completed, the North Branch discharge into Bear Creek reached a concentration of 5,379 μg/ml which was comparable to the main stream of Bear Creek at the weir analyzing 8,780 μg/ml. North Branch nitrates appear to discharge from deep aquifers because the water is above pH 7.0 and free of uranium. The flow is slightly higher than that of the main stream of Bear Creek at this point and, therefore, contributes significant nitrates to the main stream.

The effect of high nitrates (8,780 μg/g) in upper Bear Creek and the low pH of 4.0 is felt downstream well past the sanitary landfill area as indicated by the west culvert and east landfill entrance samples taken July 27th, Table V. There is, however, a significant reduction in the uranium and nitrate concentration from 22.8 and 8,780 μg/g at the weir, Table II, to 3.4 and 1,870 μg/g at the landfill site, respectively. This is a distance of approximately 0.5-mile.

The second phase of the forest fertilization experiment being conducted in co-operation with the ORNL Ecology Division was completed on July 21, 1972 following irrigation of 12 plots of hardwood forest land located on a ridge on the north side of Bear Creek Road. Cumulative spreading rates are 172 to 516 pounds of nitrates per acre. The source of the nitrate was raw water collected in upper Bear Creek at the weir site which contained 11,500 μg/g nitrate and 35 μg/g uranium. Lime hydrate was an effective precipitant and coagulant for removal of the uranium and aluminum, producing a relatively pure calcium nitrate solution for the fertilization experiment. Further applications will be added until cumulative spreading rates of 200, 500 and 800 pounds per acre are attained.

Mr. Frank W. Harris of the Environmental Sciences Division, ORNL, is conducting a sampling program for use in evaluating the effect of nitrates on the forest ecosystems. This work includes collection of soil, water and foliage samples which are being analyzed to determine the bioaccumulation of significant elements and an evaluation of the forest landscape to absorb neutralized effluent materials.

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TABLE I

POPLAR CREEK NITRATES - AT STORM SEWER OUTFALL NEAR 9720-5

July 1972	Y-12 Rainfall (Inches)	pH At Outfall	Flow (gpm)	Flow (10^6 lbs/day)	Nitrates (µg/g)	Nitrates (lbs/day)	Uranium (µg/g)	Uranium (lbs/da
1	-	7.3	585	7.0	52	364	0.02	0.14
2	0.02	7.3	660	7.9	41	324		
3	-	7.4	660	7.9	45	356		
4	0.69	7.4	700	8.4	38	319		
5	-	7.3	740	8.9	62	552		
6	-	7.0	700	8.4	59	496	0.02	0.16
7	-	7.1	585	7.0	53	371		
8	-	7.2	660	7.9	44	348		
9	-	6.9	660	7.9	50	395		
10	-	7.0	700	8.4	50	420		
11	-	7.0	700	8.4	45	378		
12	-	7.1	700	8.4	47	395		
13	-	7.2	660	7.9	48	379		
14	0.03	7.1	660	7.9	48	379		
15	-	7.0	585	7.0	52	364	0.02	0.14
16	-	7.1	585	7.0	52	364		
17	0.26	6.9	585	7.0	52	364	0.01	0.07
18	-	7.1	585	7.0	72	504		
19	0.26	7.2	585	7.0	61	427		
20	-	7.2	660	7.9	70	553		
21	-	7.3	660	7.9	53	419		
22	-	7.2	620	7.4	53	392		
23	-	7.3	540	6.5	59	384		
24	-	7.0	540	6.5	48	312		
25	1.38	7.2	540	6.5	49	319		
26	-	7.6	520	6.2	68	422		
27	0.92	7.6	485	5.8	53	307	0.01	0.06
28	0.37	7.2	860	10.3	74	762		
29	0.44	7.1	860	10.3	65	670		
30	0.17	7.0	660	7.9	68	537		
31	0.18	7.0	700	8.4	68	571		
TOTAL/Mo.	4.72					13,147		

TABLE II

BEAR CREEK NITRATES - 0.3 MILE WEST OF S-3 PONDS

July 1972	Y-12 Rainfall (Inches)	pH At Weir	Depth (Inches)	Flow (gpm)	Nitrates (µg/g)	Nitrates (lbs/day)	Uranium (µg/g)	Uranium (lbs/day)
1	-	3.8	1.7	9	3,917	423	12.5	1.4
2	0.02	3.7	1.3	5	5,177	311		
3	-	3.7	1.3	5	5,986	359		
4	0.69	3.6	1.3	5	7,034	422		
5	-	4.2	2.5	24	1,023	295		
6	-	3.8	2.0	12	2,585	372	9.1	1.3
7	-	3.6	1.6	8	4,179	401		
8	-	3.5	1.4	6	5,012	361		
9	-	3.5	1.2	4	6,000	288		
10	-	3.6	1.1	3	6,997	252		
11	-	3.4	1.0	2.8	7,647	257		
12	-	3.6	1.0	2.8	8,137	273		
13	-	3.5	1.0	2.8	9,328	313	29.2	1.0
14	0.03	3.4	1.0	2.8	9,859	331		
15	-	3.4	0.9	2.0	10,391	249		
16	-	3.5	0.9	2.0	10,820	260		
17	0.26	3.5	0.9	2.0	10,800	259	34.7	0.8
18	-	3.8	2.3	18.0	2,279	492		
19	0.26	3.8	1.5	7.0	4,465	313		
20	-	4.5	3.3	44.0	1,000	528	2.7	1.4
21	-	3.9	1.7	9.0	2,651	286	9.0	1.0
22	-	3.7	1.6	8.0	3,969	381		
23	-	3.6	1.5	7.0	5,287	444		
24	-	4.1	1.3	5.0	6,114	367	22.4	1.3
25	1.38	3.5	1.3	5.0	7,433	357		
26	-	3.9	1.5	7.0	7,831	658	22.8	1.9
27	0.92	4.0	1.3	5.0	8,780	527		
28	0.37	4.4	3.5	50.0	690	414		
29	0.44	4.2	3.8	63.0	892	674		
30	0.17	4.2	3.6	53.0	1,113	708		
31	0.18	4.4	3.3	44.0	1,517	801		
TOTAL/Mo.	4.72					12,376		

TABLE III

TOTAL NITRATES BY MONTHS IN BEAR CREEK AND POPLAR CREEK

Month	Rainfall	Total Lbs. NO_3	
		Poplar Creek	Bear Creek
July	8.76	11,000 (Est.)	13,257
August	2.36	10,517	18,672
September	2.84	9,189	4,166
October	2.01	11,113	4,687
November	1.94	14,694	5,363
December	6.12	11,460	19,053
January	7.15	16,909	29,120
February	4.77	14,379	31,432
March	6.02	18,456	36,272
April	2.99	15,284	30,964
May	5.15	14,984	22,947
June	4.03	15,701	12,534
July	4.72	13,147	12,376

TABLE IV

S-3 DISPOSAL POND SOLUTION ELEVATIONS BY MONTHS

Date	Pond (Elevation-Feet)			
	NE	SE	NW	SW
July 21, 1971	1013.8	1011.7	1013.3	1011.2
August 12, 1971	1014.0	1011.9	1013.7	1011.5
September 3, 1971	1013.6	1011.4	1012.7	1011.0
October 12, 1971	1013.8	1011.3	1012.2	1010.5
November 9, 1971	1013.8	1011.1	1012.0	1010.2
December 14, 1971	1013.8	1011.0	1012.6	1010.3
January 7, 1972	1013.9	1011.5	1013.6	1010.8
February 10, 1972	1013.8	1011.7	1013.8	1011.2
March 8, 1972	1014.4	1012.0	1014.2	1011.7
April 4, 1972	1014.4	1012.0	1014.2	1012.0
May 2, 1972	1013.8	1012.0	1013.8	1012.0
June 5, 1972	1013.7	1011.7	1013.7	1012.2
July 5, 1972	1013.9	1011.4	1013.5	1011.7
August 2, 1972	1014.0	1011.3	1013.3	1011.3

TABLE V

NITRATE AND URANIUM ANALYSES - UPPER BEAR CREEK

Date	Location Of Sample	Distance To S-3 Ponds (~ mi)	pH	NO_3 (µg/ml)	Soluble Uranium (µg/ml)
6-29-72(1)	Inlet to Culvert, Bear Creek Road	0.75	4.4	1,201	1.11
"	West Branch Bear Creek, Outlet	0.75	6.5	61	0.01
"	North Branch Bear Creek, Culvert	0.3	7.0	4	< 0.01
6-30-72(1)	Landfill Pit Water	1.1	6.4	30	0.03
"	Bear Creek At West Landfill Entrance	1.2	6.8	786	-
"	West Gate Bear Creek Burial Ground	1.7	6.8	694	0.06
7-3-72	Bear Creek At East Landfill Entrance	0.8	4.4	1,946	-
7-20-72(2)	Bear Creek At Highway 95 Spillway	4.9	8.2	60	0.09
7-24-72	West Gate, Bear Creek Burial Ground	1.7	5.3	941	1.10
7-26-72	West Gate, Bear Creek Burial Ground	1.7	6.3	651	0.14
"	Bear Creek Spring No. 2	1.8	8.0	217	0.02
7-27-72	North Branch Bear Creek, At Outlet	0.33	7.5	5,379	0.01
"	Inlet To West Culvert, Bear Creek Road	0.75	4.3	2,409	3.9
"	Bear Creek At East Landfill Entrance	0.8	4.4	1,870	3.4
7-28-72	Inlet To Culvert, Bear Creek Road	0.75	4.4	1,315	2.2
7-31-72(3)	Excavated Pool, Overflow	0.33	4.5	1,131	-
8-2-72	Bear Creek At East Landfill Entrance	0.8	5.8	1,056	0.96

(1) Sampled following rainfall amounting to 2.28 and 0.03 inches, June 28 - 29.

(2) Sampled following 1.54 inches of rainfall over a 3-day period as recorded on Bear Creek rain gauge.

(3) Sampled following 2.0 inches of rainfall over five consecutive days.

TABLE VI

SPECTROCHEMICAL ANALYSES BEAR CREEK WATER

Location Ion	Upper West Branch (6-6-72) (µg/g)	Upper North Branch (6-6-72) (µg/g)
Ag	0.01	< 0.01
Al	0.3	0.1
As	< 0.1	< 0.1
Au	< 0.01	< 0.01
B	0.04	0.01
Ba	0.3	< 0.01
Be	< 0.01	< 0.01
Bi	< 0.1	< 0.1
Ca	200.0	10.0
Cd	< 0.01	< 0.01
Co	< 0.2	< 0.2
Cr	< 0.01	< 0.01
Cs	< 0.6	< 0.6
Cu	< 0.1	< 0.1
Fe	0.3	0.1
Ga	< 0.01	< 0.01
Ge	< 0.01	< 0.01
Hf	< 0.1	< 0.1
Hg	< 0.1	< 0.1
In	< 0.01	< 0.01
Ir	< 0.02	< 0.02
K	1.0	0.2
Li	< 0.1	< 0.1
Mg	5.0	2.0
Mn	0.01	0.3
Mo	< 0.01	0.01
Na	1.5	0.6
Nb	< 0.01	< 0.01
Ni	< 0.04	< 0.04
P	< 1.0	< 1.0
Pb	< 0.01	< 0.01
Pd	< 0.06	< 0.06
Rb	< 0.2	< 0.2
Rh	< 0.01	< 0.01
Ru	< 0.01	< 0.01
Sb	< 0.01	< 0.01
Sc	< 0.01	< 0.01
Si	3.0	1.5
Sn	< 0.01	< 0.01
Ta	< 1.0	< 1.0
Th	< 0.04	< 0.04
Ti	0.08	< 0.06
Tl	< 0.01	< 0.01
U(1)	< 0.01	< 0.01
V	< 0.01	< 0.01
W	< 0.1	< 0.1
Y	< 0.01	< 0.01
Zn	< 0.6	< 0.6
Zr	< 0.02	< 0.02

NO_3 (1)	472.0	1.4
pH	7.69	7.40

(1) Chemical analysis.

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Author(s) (Suzanne Sandberg)

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Subject Environmental Nitrate Sampling Program

The results of the August, 1972 nitrate sampling program for Poplar Creek sampled near Building 9720-5 storm sewer outfall, and upper Bear Creek Valley 0.3 mile below the S-3 disposal ponds are presented in the attached Tables I and II. Soluble uranium analyses for Bear Creek and Poplar Creek are included. Prolonged dry weather in the latter part of the month resulted in high nitrate and uranium analyses in upper Bear Creek.

A summary by months of the total nitrates at the two sampling locations is presented in Table III. S-3 acid disposal pond water elevations from August, 1971 to August, 1972 are given in Table IV.

Analytical results on a series of samples from upper Bear Creek are reported in Table V. Note that most of the sampling site locations are indicated on the upper Bear Creek Area Map, Figure 1, except for a few downstream samples. Total rainfall in September was 2.31 inches with 0.63 and 1.39 inches falling on September 2 and 9, respectively. The remainder of the month was relatively arid. As a result, both the North and West Branch tributaries of Bear Creek, Figure 1, were completely dry except for a few stagnant pools, by the end of the month. The two excavated pools, one above and one below the weir sampling site No. 1, had sufficient capacity and evaporative surface area to retain all of the high nitrate (3,000 to 11,000 µg/ml) stream flow at this location on Bear Creek; however, some seepage was detected downstream of the larger excavated pool below map sampling site No. 2, Figure 1. At the end of the month, this seepage water was pH 4.16 and contained 5,548 µg/ml nitrate and 7.87 µg/g uranium ions, Table V. The small seepage flow was augmented by additional ground water contributions as it flowed downstream to the Bear Creek highway culvert crossing at sampling site 12, Figure 1. At this location the pH was 4.34, nitrate and uranium ions were 2,892 and 3.94, respectively, on 8-29-72. The flow was approximately 2 gpm.

Samples taken from Bear Creek at the west entrance to the sanitary landfill operation gave a pH of 8.24 with low nitrate and uranium ions by the end of the month, Table V. Exploration of the creek bed revealed that the acidic flow, pH 4.34, found at sampling site No. 12 was sinking into a creek bed cavity about 200 feet downstream of sample site No. 12. Flow resumed again approximately 200 feet further downstream, about sampling point No. 23. This water appears to be emerging from a different source of ground water because of its higher pH, low nitrate and uranium content, and accounted for similar readings at the west gate to the landfill, Table V. Bear Creek at this point also receives relatively clean water from Spring No. 1. Bear Creek then continues to a point about 0.2 mile west of the landfill site where it again disappeared into cavities in the creek bed. Bear Creek was then dry for approximately 0.3 mile to where Spring No. 2 empties into the creek. From this location the flow was continuous to Spring No. 3 and beyond to the spillway at Highway 95 and to Watts Bar Lake. Springs No. 2 and 3 both contained 150 µg/ml nitrate; however, dilution from nitrate free water from other downstream springs was sufficient to reduce the nitrate level at the spillway to 43 µg/ml which is an acceptable level.

The final phase of the forest fertilization experiment being conducted in cooperation with the ORNL Ecology Division was completed August 14, 1972 on 12 plots of hardwood forest land located on a ridge on the north side of Bear Creek Highway. Figure 1 is an area map of upper Bear Creek Valley locating the 12 sprinklered plots and the four control plots. Cumulative nitrate spreading rates were: 200 lbs/ac for plots 1 to 4, 807 lbs/ac for plots 5 to 8, and 505 lbs/ac for plots 9 to 12. Plots 13 to 16, the controls, did not receive any nitrate. The 12 slightly larger plots shown on the map on the south side of Bear Creek Road denote the location of the pine stand that was irrigated in 1971.

Mr. Frank Harris, Ecologist, with the Environmental Science Division, Oak Ridge National Laboratory is continuing the preplanned sampling program for evaluating the effect of nitrates on the forest ecosystems. Forty-eight vegetative type samples were collected from the pine stand and analyses are now complete. Sixty-four soil samples to provide soil nitrogen baseline data, prior to irrigation of the hardwood forests are about 90% completed.

Six drums of neutralized Bear Creek water, containing 0.96 pounds of nitrate per gallon were used to irrigate approximately 0.1205 acre of Kenaf, under experimental cultivation by the Ecology Division, Oak Ridge National Laboratory. One-half of the irrigated plot also received 25 pounds of lime hydrate powder. The nitrate application rate was approximately 2,280 lbs/ac. Follow-up moisture and vegetative samples are planned to determine the uptake of nitrogen. Examination of the plot one week after application of the nitrate solution showed a noticeable vegetative response. Kenaf is a new crop being introduced from South Africa by the Department of Agriculture. It is a fast growing, highly productive crop that can be harvested as a source of raw material for pulp used in paper manufacture and as a high protein cattle food.

H C Francke

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TABLE I

POPLAR CREEK NITRATES - AT STORM SEWER OUTFALL NEAR 9720-5

Aug. 1972	Y-12 Rainfall (Inches)	pH At Outfall	Flow (gpm)	Flow (10^6 lbs/day)	Nitrates (µg/g)	Nitrates (lbs/day)	Uranium (µg/g)	Urani (lbs/d
1	-	7.0	505	6.1	70	427	-	-
2	0.63	7.5	505	6.1	60	366	0.08	0.4
3	-	7.2	620	7.4	64	474	-	-
4	-	7.1	585	7.0	57	399	-	-
5	-	7.2	450	5.4	55	297	0.05	0.2
6	0.16	7.2	450	5.4	58	313	-	-
7	0.09	7.6	485	5.8	53	307	-	-
8	-	7.5	485	5.8	70	406	-	-
9	1.39	7.6	2,600	31.2	39	1,217	-	-
10	-	7.3	540	6.5	72	468	-	-
11	-	7.4	505	6.1	57	348	-	-
12	-	7.2	660	7.9	43	340	-	-
13	-	7.5	680	8.2	39	320	-	-
14	-	7.5	710	8.5	38	323	-	-
15	-	7.6	680	8.2	48	394	-	-
16	-	7.5	710	8.5	46	391	-	-
17	-	7.5	680	8.2	49	402	-	-
18	-	7.6	710	8.2	43	353	-	-
19	-	7.6	660	7.9	54	427	0.02	0.1
20	-	7.6	620	7.4	62	459	-	-
21	-	7.5	485	5.8	65	377	-	-
22	-	7.5	505	6.1	67	409	-	-
23	0.04	7.6	710	8.5	44	374	-	-
24	-	7.5	710	8.5	51	434	-	-
25	-	7.6	505	6.1	66	403	-	-
26	-	7.6	485	5.8	68	394	0.03	0.1
27	-	7.7	485	5.8	69	400	-	-
28	-	7.6	450	5.4	72	389	-	-
29	-	7.5	660	7.9	51	403	-	-
30	-	7.7	505	5.0	64	320	-	-
31	-	7.5	1,100	13.2	24	317	0.01	0.1
Total/Mo.	2.31					12,651		

TABLE II

BEAR CREEK NITRATES - 0.3 MILE WEST OF S-3 PONDS

Aug. 1972	Y-12 Rainfall (Inches)	pH At Weir	Depth (Inches)	Flow (gpm)	Nitrates (µg/g)	Nitrates (lbs/day)	Uranium (µg/g)	Uranium (lbs/day)
1	-	4.0	4.0	70.0	2,307	1,938	-	-
2	0.63	4.2	2.0	12.0	3,351	482	9.6	1.4
3	-	4.2	4.8	110.0	1,269	1,675	-	-
4	-	4.1	3.5	50.0	2,799	1,679	-	-
5	-	4.1	2.6	23.0	3,522	972	11.7	3.2
6	0.16	3.7	1.8	12.0	4,423	637	-	-
7	0.09	4.1	1.8	12.0	4,846	698	-	-
8	-	3.8	1.3	5.0	5,306	318	17.1	2.5
9	1.39	4.1	1.6	8.0	5,563	534	-	-
10	-	5.0	5.0	123.0	997	1,472	1.9	2.8
11	-	4.4	2.5	22.0	1,835	484	-	-
12	-	4.3	1.8	12.0	3,027	436	-	-
13	-	4.1	2.8	28.0	3,424	1,150	-	-
14	-	4.1	2.2	16.0	4,219	810	-	-
15	-	4.1	1.8	12.0	5,361	772	-	-
16	-	4.1	1.8	12.0	5,744	827	-	-
17	-	4.1	1.7	9.0	4,429	478	-	-
18	-	4.0	1.5	7.0	4,583	385	-	-
19	-	4.2	1.2	4.0	5,812	279	23.0	1.1
20	-	4.0	1.2	4.0	6,058	291	-	-
21	-	4.0	1.1	3.4	6,997	285	-	-
22	-	4.0	1.1	3.4	7,469	305	-	-
23	0.04	3.9	1.1	3.4	7,040	287	-	-
24	-	4.0	1.1	3.4	8,305	339	-	-
25	-	3.9	1.0	2.6	9,386	292	-	-
26	-	3.9	1.0	2.6	10,161	317	36.1	1.1
27	-	3.8	0.9	2.0	11,241	270	-	-
28	-	3.9	0.9	2.0	11,563	278	41.3	1.0
29	-	3.9	0.8	1.7	10,268	210	-	-
30	-	4.0	0.7	1.1	11,187	148	46.0	0.6
31	-	4.0	0.7	1.1	10,861	143	-	-
Total/Mo.	2.31					19,191		

TABLE III

TOTAL NITRATES BY MONTHS IN BEAR CREEK AND POPLAR CREEK

Month	Rainfall	Total Lbs. NO_3	
		Poplar Creek	Bear Creek
July	8.76	11,000 (Est.)	13,257
August	2.36	10,517	18,672
September	2.84	9,189	4,166
October	2.01	11,113	4,687
November	1.94	14,694	5,363
December	6.12	11,460	19,053
January	7.15	16,909	29,120
February	4.77	14,379	31,432
March	6.02	18,456	36,272
April	2.99	15,284	30,964
May	5.15	14,984	22,947
June	4.03	15,701	12,534
July	4.72	13,147	12,376
August	2.31	12,651	19,191

TABLE IV

S-3 DISPOSAL POND SOLUTION ELEVATIONS BY MONTHS

Date	Pond (Elevation-Feet)			
	NE	SE	NW	SW
July 21, 1971	1013.8	1011.7	1013.3	1011.2
August 12, 1971	1014.0	1011.9	1013.7	1011.5
September 3, 1971	1013.6	1011.4	1012.7	1011.0
October 12, 1971	1013.8	1011.3	1012.2	1010.5
November 9, 1971	1013.8	1011.1	1012.0	1010.2
December 14, 1971	1013.8	1011.0	1012.6	1010.3
January 7, 1972	1013.9	1011.5	1013.6	1010.8
February 10, 1972	1013.8	1011.7	1013.8	1011.2
March 8, 1972	1014.4	1012.0	1014.2	1011.7
April 4, 1972	1014.4	1012.0	1014.2	1012.0
May 2, 1972	1013.8	1012.0	1013.8	1012.0
June 5, 1972	1013.7	1011.7	1013.7	1012.2
July 5, 1972	1013.9	1011.4	1013.5	1011.7
August 2, 1972	1014.0	1011.3	1013.3	1011.3
September 5, 1972	1014.0	1011.0	1012.7	1010.9

TABLE V

NITRATE AND URANIUM ANALYSES - UPPER BEAR CREEK

Date		Map Sampling Site No.(1)	pH	(µg/ml)	Solubl Uraniu (µg/g)
8-2-72	Bear Creek At East Landfill Entrance	23	5.76	1,056	0.96
8-8-72	Seepage Below Excavated Pool	2	4.16	784	0.12
8-29-72	Seepage Below Excavated Pool	2	4.16	5,548	7.87
8-29-72	Inlet To Culvert At Highway	12	4.34	2,892	3.94
8-29-72	Bear Creek At West Landfill Entrance	-	8.24	228	1.13
8-30-72	Bear Creek At West Landfill Entrance	-	8.24	86	1.16
8-30-72	Bear Creek, Spring No. 2	-	7.75	150	0.12
8-30-72	Bear Creek, Spring No. 3	-	7.47	149	0.07
8-30-72	Bear Creek At Highway 95 Spillway	-	7.81	43	0.10
9-3-72	Outlet To Culvert At Highway	12	4.21	2,973	4.45
9-3-72	Bear Creek At East Landfill Entrance	23	7.31	319	0.08
9-6-72	Bear Creek, Spring No. 1	-	7.43	< 0.2	< 0.01

(1) See Figure 1. Unnumbered sampling sites are downstream of map.

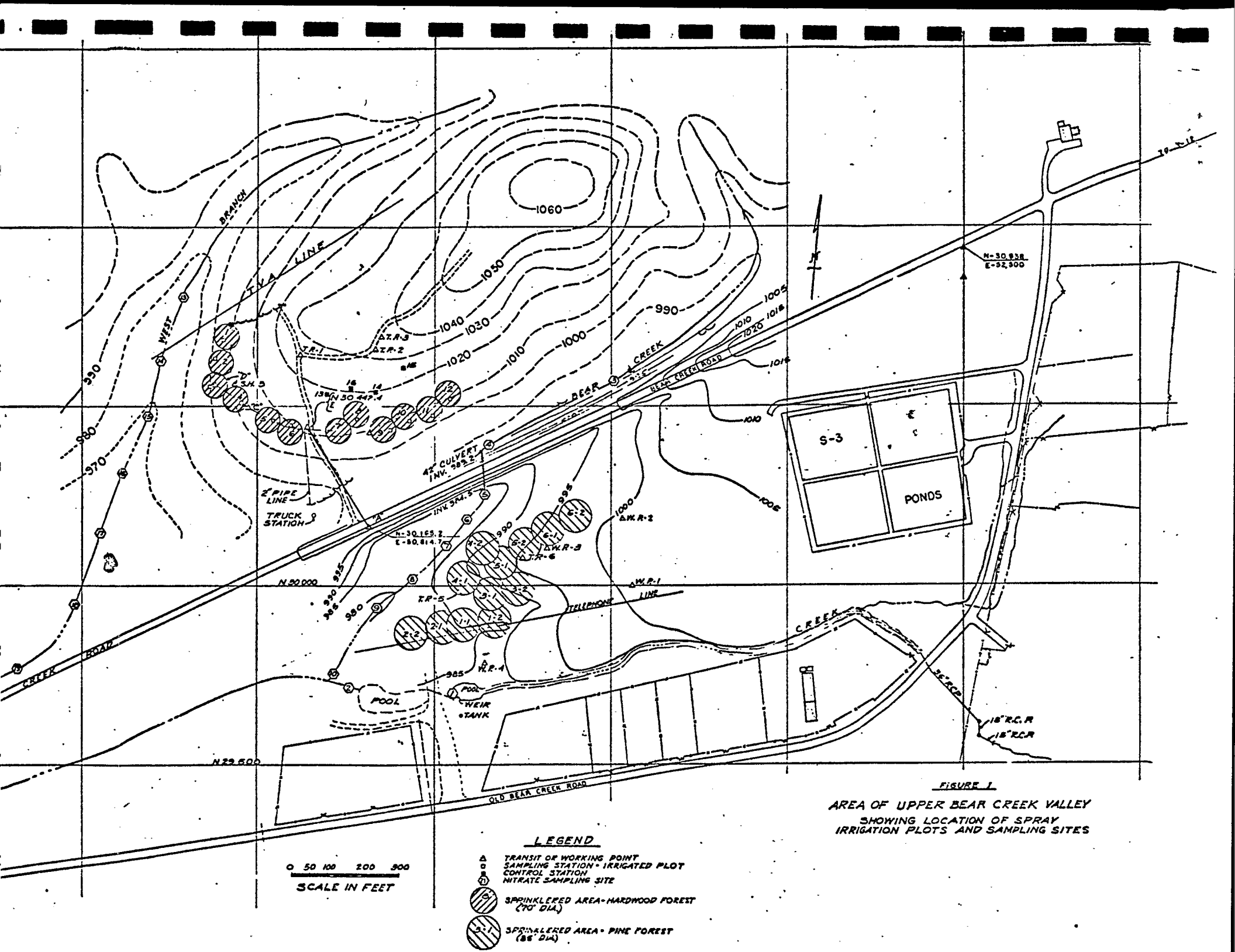
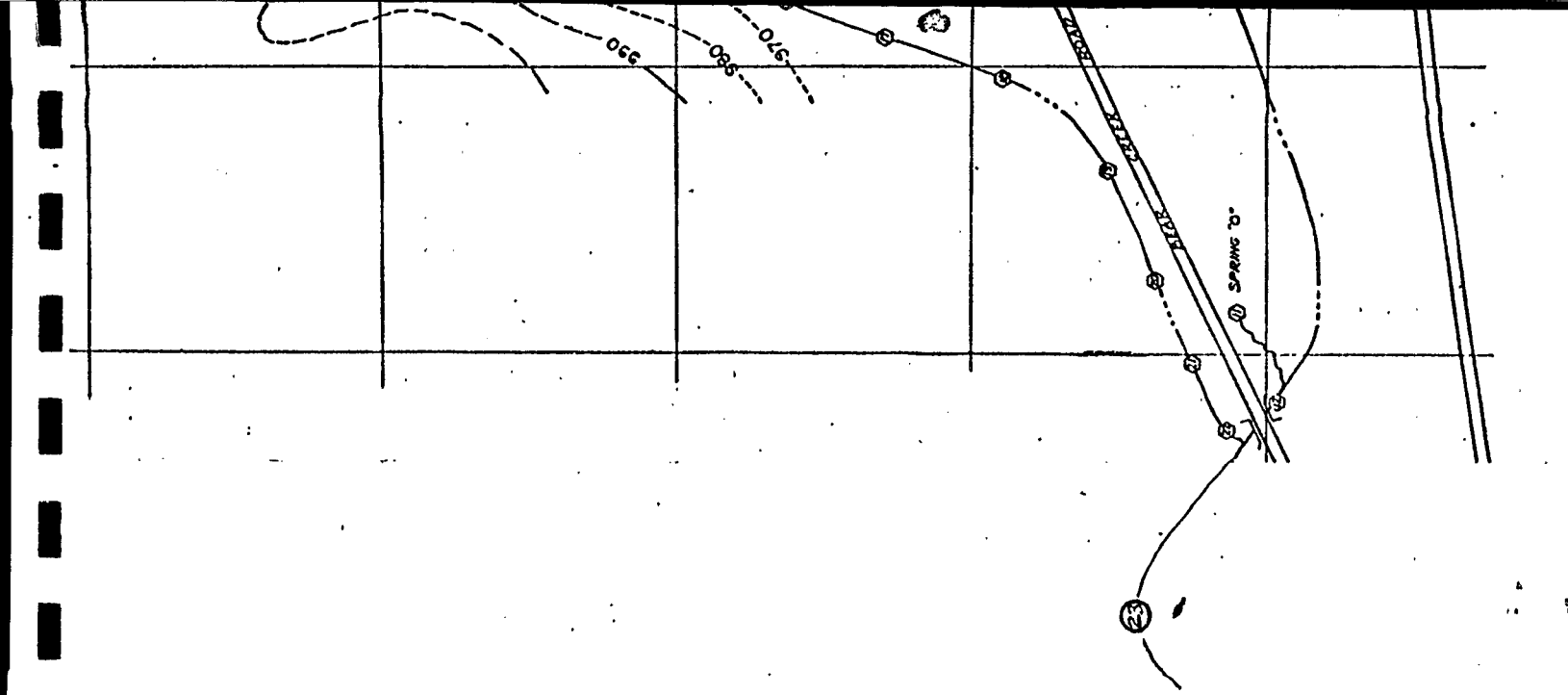


FIGURE 1

AREA OF UPPER BEAR CREEK VALLEY
SHOWING LOCATION OF SPRAY
IRRIGATION PLOTS AND SAMPLING SITES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Subject Environmental Nitrate Sampling Program

The results of the September, 1972 nitrate sampling program for Poplar Creek sampled near Building 9720-5 storm sewer outfall, and upper Bear Creek Valley 0.3 mile below the S-3 disposal ponds are presented in the attached Tables I and II. A few soluble uranium analyses for Bear Creek and Poplar Creek are included. Dry weather during the greater part of the month resulted in high nitrate and uranium analyses in upper Bear Creek, except following heavy rainfall on September 17 and 29, 1972.

A summary by months of the total nitrates at the two sampling locations is presented in Table III. S-3 acid disposal pond water elevations from August, 1971 to October, 1972 are given in Table IV. During September a total flow of approximately 5,000 pounds of nitrates was accounted for at weir site No. 1, Figure 1, on upper Bear Creek. This was one of the lowest months on record for nitrates, and was due to the generally prevailing dry weather conditions existing for most of the month. There were six days without any flow of water or nitrates through the weir and nineteen days with less than one gallon per minute flow of water which resulted in a minimum transport of nitrates to lower Bear Creek, Table II.

The sole continuous source of water and nitrates upstream of weir site No. 1, Figure 1, was a low flow aquifer fed by S-3 ground water analyzing 15,000 µg/g of nitrate and 60 µg/g of soluble uranium at pH 3.8. When the upstream sources above the weir dried up, the volume of water issuing from the aquifer was not sufficient to maintain flow through the weir. During the six "no flow" days, Table II, the water level in the lagoon above the weir dropped three inches below the V-notch of the weir. The lower lagoon during this same period dropped 24 inches below the overflow lip. Nitrate in the upper lagoon built up to 15,000 µg/g and was at 10,000 µg/g in the lower lagoon. Soluble uranium accumulated up to 60 µg/g in the upper lagoon. Following 1.11 inches of rainfall on September 17 1972 when flow through the weir peaked at 12 gpm, no overflow occurred at the lower lagoon; its reserve volume being sufficient to impound all upstream water.

Evaporation and seepage also helped. After approximately one week, mass flow of nitrates at the weir was averaging less than 22 pounds per day over a five-day period. During this period there was no overflow from the second lagoon and Bear Creek exhibited intermittent dry stretches to the point where Spring No. 2 enters Bear Creek, 1.7 miles west of the S-3 ponds.

On September 29 and 30, 1972 a heavy downpour of rain occurred amounting to 1.71 inches. This time, there was heavy surface runoff with the weir peaking at ~ 200 gpm. This flow was sufficient to flush nitrate out of the upper lagoon as well as the lower lagoon, Table V. Nitrate and uranium profiles were made at points along upper Bear Creek to the Spillway at Highway 95, Table V, on September 30, 1972 following the rain. It was evident that the effect of a heavy surface runoff resulted in significant transport of accumulated uranium and nitrate ions downstream. Peak concentrations appeared at culvert sampling site No. 12, Figure 1, in Bear Creek and at the west entrance to the sanitary landfill about 1.2 miles below the S-3 ponds. The pH was also low at these two sampling sites. The heavy influx of high pH surface water into the two lagoons resulted in the formation of a colloidal aluminum hydroxide precipitate which imparted a pastel bluish color to the water and, subsequently, settled on the bottom and banks as a white flocculent precipitate of aluminum hydrate. At pH 6.23 in the upper lagoon, the analysis indicated that most of the earlier 60 μg/g uranium had been either washed downstream or precipitated.

A soil sample from an unsprinklered area adjacent to hardwood sprinkler site, No. 7, Figure 1, was sent to the Referee Analysis Laboratory in the Spectrometry and Physics Methods Department of the Oak Ridge National Laboratory at Y-12 for uranium isotopic analysis. The data are presented in Table VI. A sample from a 4-foot square fallout tray 0.1 mile west of Building 9212 assayed 2.24 $^{w}/_{o}$ U-235.

Baseline data on soil samples taken from the 16 hardwood plots prior to irrigation experiments are presented in Table VII. These data include existing total nitrogen, nitrate and ammonium nitrogen, uranium and soil pH at various depths. Similar samples following spray irrigation are being analyzed at ORNL.

A 70-foot diameter cultivated plot has been prepared as a site for a sprinkler experiment using alternate spray applications of discarded oil and nitrate solutions. This experiment was set up to determine the mechanics of using spray techniques for spreading oil and to assess the effect of periodic nitrate solutions on microbial activity. Seventy gallons of oil and 40 gallons of 1 $^{w}/_{o}$ nitrate solution were applied on October 3, 1972.

H. C. Francke

HCF:wj

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TABLE I

POPLAR CREEK NITRATES - AT STORM SEWER OUTFALL NEAR 9720-5

Sept. 1972	Rainfall (Inches)	pH At Outfall	Flow (gpm)	Flow (10^6 lbs/day)	Nitrate (µg/g)	Nitrate (lbs/day)	Uranium (µg/g)
1	-	7.6	680	8.2	49	402	-
2	-	7.5	415	5.0	66	330	-
3	-	7.9	450	5.4	64	346	-
4	0.04	7.9	450	5.4	62	346	-
5	0.25	7.5	505	6.1	60	366	-
6	-	7.5	585	7.0	47	329	-
7	-	7.7	660	7.9	52	411	-
8	0.02	7.5	680	8.2	52	426	-
9	-	7.5	680	8.2	46	377	-
10	-	7.6	660	7.9	43	340	0.02
11	-	7.6	660	7.9	43	340	-
12	-	7.6	660	7.9	46	363	-
13	-	7.7	660	7.9	46	363	-
14	-	7.7	660	7.9	46	363	-
15	-	7.8	660	7.9	45	356	-
16	-	7.8	660	7.9	45	356	-
17	1.11	7.5	1,060	12.7	100	1,270	-
18	-	7.6	770	9.2	51	469	-
19	-	7.6	485	5.8	56	325	-
20	-	7.7	620	7.4	43	318	-
21	-	7.8	660	7.9	41	324	-
22	-	7.7	485	5.8	51	296	-
23	0.02	7.7	505	6.1	47	287	-
24	-	7.7	505	6.1	47	287	-
25	-	7.6	505	6.1	46	281	-
26	0.12	7.6	505	6.1	46	281	-
27	0.12	7.7	505	6.1	45	275	-
28	-	7.6	505	6.1	48	293	-
29	1.58	7.7	420	5.0	55	275	-
30	0.13	7.6	1,100	13.2	78	1,030	-
Total/mo.	3.39					11,825	

TABLE II

BEAR CREEK NITRATES - 0.3 MILE WEST OF S-3 PONDS

Sept. 1972	Rainfall (Inches)	pH At Weir	Depth (Inches)	Flow (gpm)	Nitrate (µg/g)	Nitrate (lbs/day)	Uranium (µg/g)	Uranium (lbs/day)
1	-	3.9	0.7	1.1	11,447	151	-	-
2	-	3.9	0.7	1.1	12,428	164	-	-
3	-	3.9	0.6	0.8	12,244	118	-	-
4	0.04	3.9	0.6	0.8	12,429	119	49.1	0.47
5	0.25	4.0	0.7	1.1	10,774	142	-	-
6	-	3.8	0.6	0.8	12,582	121	-	-
7	-	3.8	0.4	0.4	13,531	65	-	-
8	0.02	3.8	0.3	0.1	13,839	17	-	-
9	-	3.8	0.3	0.1	12,950	16	-	-
10	-	3.8	0.3	0.1	13,502	16	-	-
11	-	3.9	No Flow At Weir		13,502	No Flow	-	-
12	-	3.9	" " " "		-	" "	-	-
13	-	3.9	" " " "		14,391	" "	59.0	No Flow
14	-	3.9	" " " "		-	" "	-	-
15	-	3.8	" " " "		15,063	" "	-	-
16	-	3.8	" " " "		-	" "	-	-
17	1.11	4.1	1.8	12.0	4,368	629	-	-
18	-	4.0	1.5	7.0	5,957	500	-	-
19	-	4.0	1.2	4.0	5,527	265	-	-
20	-	4.0	1.2	4.0	7,264	349	-	-
21	-	4.0	1.0	2.6	8,163	255	-	-
22	-	4.0	0.9	2.0	8,352	200	-	-
23	0.02	4.0	0.7	1.1	8,388	111	30.7	0.41
24	-	4.0	0.5	0.4	8,879	43	-	-
25	-	3.9	0.4	0.2	10,023	24	-	-
26	0.12	3.9	0.4	0.2	10,000	24	-	-
27	0.12	3.9	0.4	0.2	9,839	24	-	-
28	-	3.9	0.4	0.2	11,004	26	-	-
29	1.58	3.9	0.3	0.1	10,840	13	-	-
30	0.13	6.2	6.0	196.0	696	1,637	0.1	0.23
Total/mo	3.39					5,029		

TABLE III

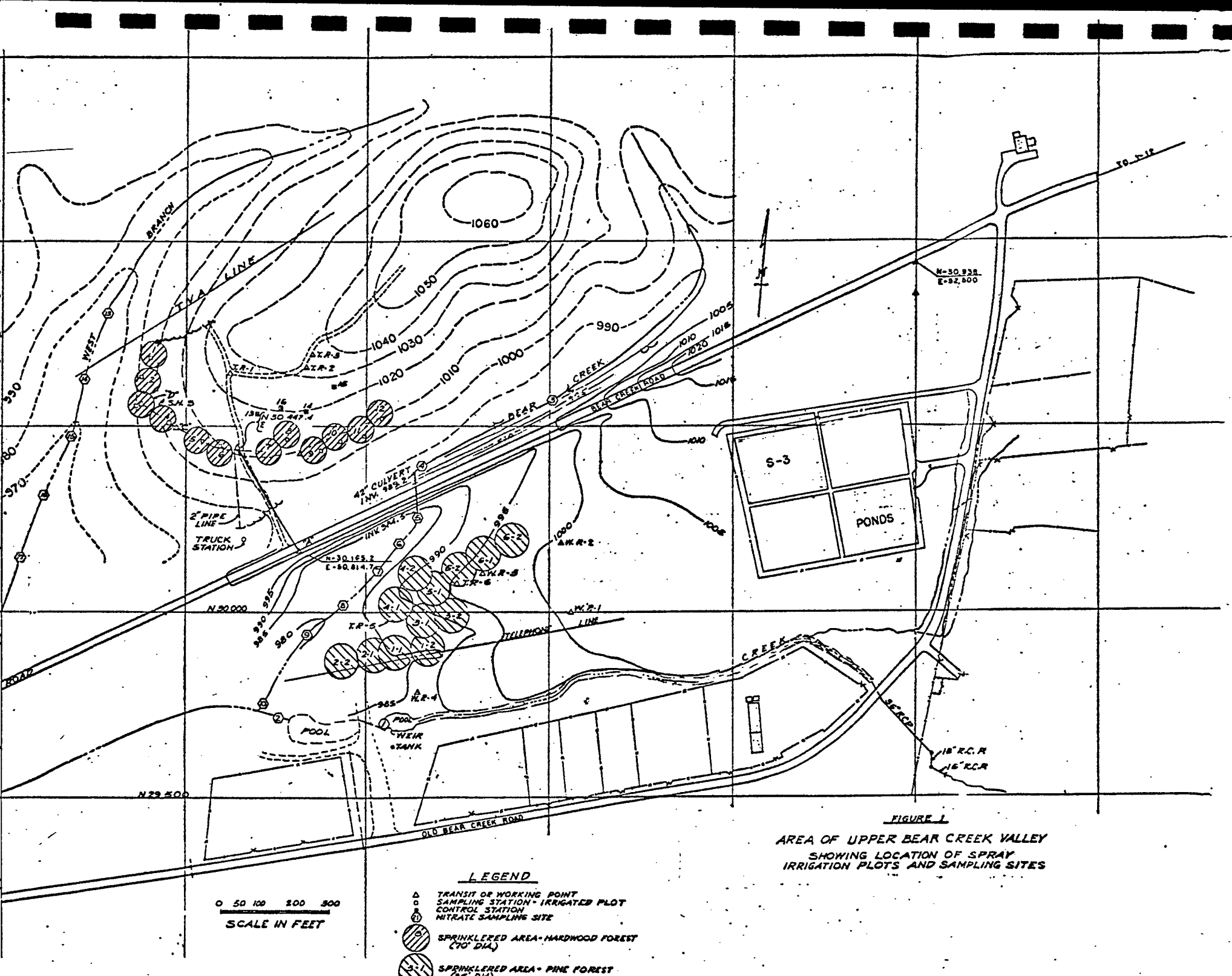
TOTAL NITRATES BY MONTHS IN BEAR CREEK AND POPLAR CREEK

Month	Rainfall	Total Lbs. NO_3	
		Poplar Creek	Bear Creek
July	8.76	11,000 (Est.)	13,257
August	2.36	10,517	18,672
September	2.84	9,189	4,166
October	2.01	11,113	4,687
November	1.94	14,694	5,363
December	6.12	11,460	19,053
January	7.15	16,909	29,120
February	4.77	14,379	31,432
March	6.02	18,456	36,272
April	2.99	15,284	30,964
May	5.15	14,984	22,947
June	4.03	15,701	12,534
July	4.72	13,147	12,376
August	2.31	12,651	19,191
September	3.39	11,825	5,029

TABLE IV

S-3 DISPOSAL POND SOLUTION ELEVATIONS BY MONTHS

Date	Pond (Elevation-Feet)			
	NE	SE	NW	SW
July 21, 1971	1013.8	1011.7	1013.3	1011.2
August 12, 1971	1014.0	1011.9	1013.7	1011.5
September 3, 1971	1013.6	1011.4	1012.7	1011.0
October 12, 1971	1013.8	1011.3	1012.2	1010.5
November 9, 1971	1013.8	1011.1	1012.0	1010.2
December 14, 1971	1013.8	1011.0	1012.6	1010.3
January 7, 1972	1013.9	1011.5	1013.6	1010.8
February 10, 1972	1013.8	1011.7	1013.8	1011.2
March 8, 1972	1014.4	1012.0	1014.2	1011.7
April 4, 1972	1014.4	1012.0	1014.2	1012.0
May 2, 1972	1013.8	1012.0	1013.8	1012.0
June 5, 1972	1013.7	1011.7	1013.7	1012.2
July 5, 1972	1013.9	1011.4	1013.5	1011.7
August 2, 1972	1014.0	1011.3	1013.3	1011.3
September 5, 1972	1014.0	1011.0	1012.7	1010.9
October 4, 1972	1013.9	1010.8	1012.7	1010.5



LEGEND

- TRANSIT OR WORKING POINT
- SAMPLING STATION - IRRIGATED PLOT
- CONTROL STATION
- NITRATE SAMPLING SITE
- SPRINKLERED AREA - HARDWOOD FOREST (70' DIA.)
- SPRINKLERED AREA - PINE FOREST (85' DIA.)

FIGURE 1

AREA OF UPPER BEAR CREEK VALLEY
SHOWING LOCATION OF SPRAY IRRIGATION PLOTS AND SAMPLING SITES

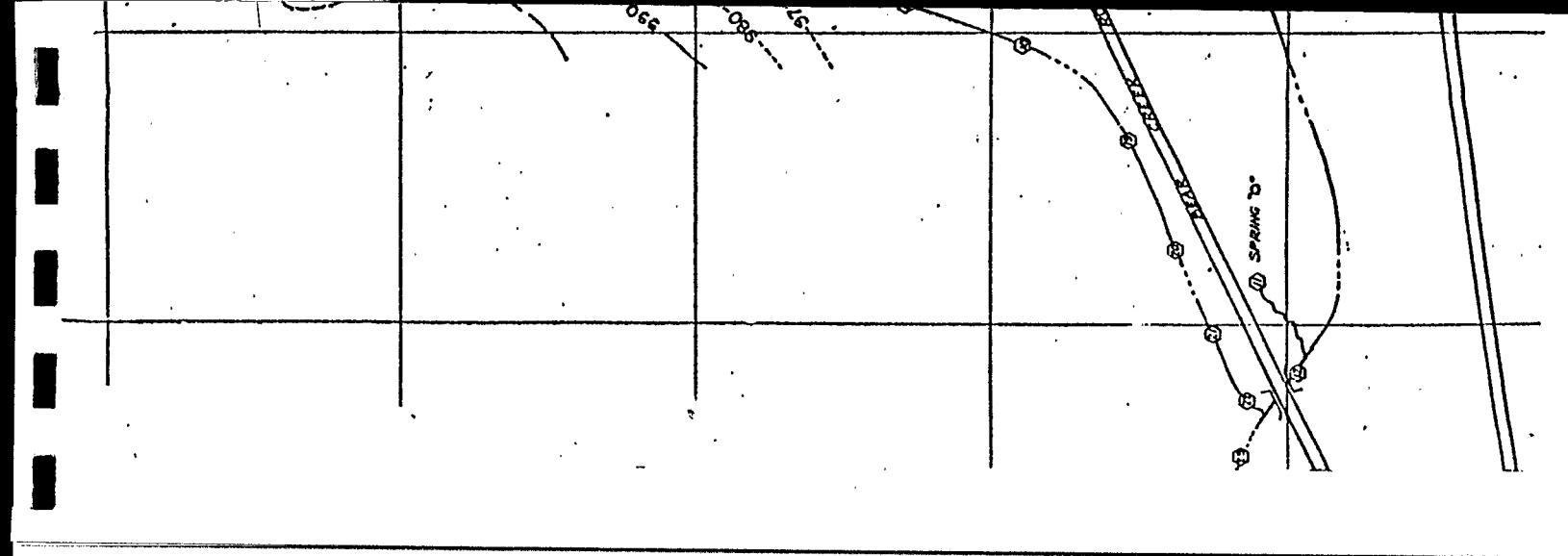

SPRING P.O.

TABLE V

NITRATE AND SOLUBLE URANIUM PROFILE OF BEAR CREEK FOLLOWING 1.71 INCHES OF RAINFALL WHEN PRECEDED BY DRY WEATHER

Location Of Sample	Distance To S-3 Pond (Mi.)	pH	NO_3 (μg/ml)	U (μg/ml)
Weir Station, Site No. 1 (196 gpm)	0.3	6.23	696	0.08
Outflow From Large Lagoon Below Weir Station	0.3	5.04	794	1.22
Inlet To Culvert Bear Creek Road	0.7	4.79	1,747	1.01
West Entrance To Sanitary Landfill	1.2	5.34	1,110	0.71
Bear Creek Bridge	2.3	7.07	506	0.09
Spillway At Highway 95 (1,333 gpm)	5.0	7.08	342	0.25

Sampled 2 p.m. 9-30-72.

TABLE VI

URANIUM ISOTOPIC ANALYSES - SOIL SAMPLE

Isotope	w/o
U-233	< 0.0001
U-234	0.021
U-235	1.89
U-236	0.0076
U-238	98.01

TABLE VII

CHEMICAL ANALYSES SOIL SAMPLES FROM HARDWOOD FOREST SITE
PARTS PER MILLION

Sample No.	Depth (In.)	Total-N	NO_3-N	NH_4-N	U	pH
1-1	0-6	857	35	58	2.76	4.86
1-1	6-12	635	13	58	-	-
1-1	12-18	541	12	32	-	-
1-1	18-24	461	9	30	-	5.15
2-1	0-6	887	44	91	3.24	4.73
2-1	6-12	354	8	29	-	-
2-1	12-18	325	7	21	-	-
2-1	18-24	276	7	17	-	5.00
3-1	0-6	1,232	68	81	3.22	4.92
3-1	6-12	413	12	26	-	-
3-1	12-18	319	9	11	-	-
3-1	18-24	272	7	15	-	4.95
4-1	0-6	788	14	93	3.75	4.92
4-1	6-12	512	15	43	-	-
4-1	12-18	397	11	27	-	-
4-1	18-24	358	5	14	-	-
5-1	0-6	1,331	33	154	6.41	4.74
5-1	6-12	615	18	71	-	-
5-1	12-18	394	10	30	-	-
5-1	18-24	451	8	18	-	4.86
6-1	0-6	1,450	53	158	7.92	5.31
6-1	6-12	554	16	57	-	-
6-1	12-18	547	19	50	-	-
6-1	18-24	338	12	20	-	-
7-1	0-6	714	28	71	0.99	4.95
7-1	6-12	599	17	42	-	-
7-1	12-18	604	10	66	-	-
7-1	18-24	421	15	34	-	4.98
8-1	0-6	1,289	37	154	5.01	5.20
8-1	6-12	485	17	46	-	-

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Title of requested document Environmental Nitrate Sampling Program

Document Number S03528; S03526; S03524; S03522; S03517

Access Number of Document _____ Date of Document July-Nov. 1972

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Derivative Classifier Sara H. Welch Phone 4-7864

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MS/ChR-503522/K-25	6-8475		

Unclassified Title: Environmental Nitrate Sampling Program

Author(s) (Suzanne Sandberg)

TYPE: ☐ Formal Report ☐ Informal Report ☐ Progress/Status Report ☐ Co-Op Report ☐ Thesis/Term Paper

☐ Oral Presentation (identify meeting, sponsor, location, date): _____

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Document number S03528, S03526, S03524, S03522, S0357 Pages _____

Document title Environmental Nitrate Sampling Program

Author(s) (indicate other divisions or organizations, if applicable) Franke, H. C.

Document type (See Doc. Prep. Guide, Chs. 1 and 2, for definitions of document types):

☐ Formal Report ☐ Progress Report ☐ Informal R&D Report ☐ Abstract ☐ Drawing

☐ Administrative ☒ Correspondence ☐ Internal Technical Data ☐ Photo ☐ Other Visuals

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INTERNAL CORRESPONDENCE

503517

NUCLEAR DIVISION

POST OFFICE BOX Y, OAK RIDGE, TENNESSEE 37830

To (Name) Mr. J. M. Napier

Division

Location

Date November 13, 1972

Originating Dept.

Y-12

Answering letter date

Copy to Listed Distribution

Subject Environmental Nitrate Sampling And Forest Fertilization Programs

The results of the October, 1972 nitrate sampling program for Poplar Creek sampled near Building 9720-5 storm sewer outfall, and upper Bear Creek Valley 0.3 mile below the S-3 disposal ponds are presented in the attached Tables I and II. Wet weather during the greater part of the month resulted in generally lower nitrate concentrations because of surface runoff dilution. Nitrate concentrations at the weir sampling station on Bear Creek varied from 170 to 6,000 µg/ml in October versus 700 to 15,000 µg/ml in September. Rainfall was 3.39 inches in September versus 6.91 inches in October which was a record rainfall for October a normally dry month.

S-3 acid disposal pond water elevations from July, 1971 to November, 1972 are given in Table III. Because of the heavy rainfall during October, the S-3 pond impoundment levels are now at elevations normally reached early in January. A summary by months of the total nitrates at the two designated sampling locations is presented in Table IV. The total quantity of nitrate was significantly higher in Bear Creek for October than in September.

Mr. Frank Harris, Ecologist at Oak Ridge National Laboratory, is evaluating the effect of nitrates on the forest ecosystems following spray irrigation with calcium nitrate solutions. His preliminary evaluations entitled: (1) "Summary of Nitrogen Concentrations In Soil Water Collected At Two-Foot Depth On Forest Irrigation Plots," dated October 5, 1972, and (2) "Results Of Forest Irrigation Project: Organic Matter Losses From Forest Litter," dated October 25, 1972, indicate significant responses in substrate organic matter, particularly in the biologically active upper soil horizon. The memos are made a part of this report to provide more detailed information for those desiring additional information on the subject matter.

H. C. Francke

H. C. Francke

HCF:wj

Attachments (12)

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TABLE I

POPLAR CREEK NITRATES - AT STORM SEWER OUTFALL NEAR 9720-5

Oct. 1972	Y-12 Rainfall (inches)	pH At Outfall	Flow (gpm)	Flow (10^6 lbs/day)	Nitrates (µg/g)	Nitrates (lbs/day)	Uranium (µg/g)
1	-	7.9	345	4.1	71	291	-
2	-	7.8	360	4.3	65	280	-
3	-	7.9	360	4.3	45	194	-
4	1.41	7.9	360	4.3	45	194	0.05
5	-	7.5	600	7.2	52	374	-
6	-	7.8	415	5.0	58	290	-
7	-	7.7	360	4.3	61	262	-
8	-	7.6	345	4.1	60	246	-
9	-	7.6	345	4.1	60	246	-
10	-	7.5	360	4.3	59	254	-
11	-	7.5	360	4.3	65	280	-
12	0.03	7.5	360	4.3	68	292	-
13	0.89	7.6	600	7.2	60	432	-
14	-	7.6	345	4.1	75	308	-
15	-	7.6	345	4.1	85	349	-
16	0.14	7.7	360	4.3	70	301	-
17	1.72	7.4	1,500	18.0	71	1,278	0.18
18	1.27	7.6	3,300	39.6	42	1,663	-
19	0.66	7.6	1,800	21.6	34	734	-
20	-	7.7	485	5.8	53	307	-
21	-	7.6	450	5.4	55	297	-
22	-	7.5	450	5.4	55	297	-
23	0.15	7.3	420	5.0	54	270	-
24	-	7.6	420	5.0	69	345	-
25	-	7.6	420	5.0	63	315	-
26	-	7.6	420	5.0	69	345	-
27	0.47	7.6	360	4.3	66	284	-
28	0.06	7.6	660	7.9	77	608	-
29	-	7.6	485	5.8	70	406	-
30	0.01	7.6	360	4.3	67	288	-
31	0.10	7.2	1,060	12.7	93	1,181	-
Total/mo.	6.91					13,211	

TABLE II

BEAR CREEK NITRATES - 0.3 MILE WEST OF S-3 PONDS

Oct. 1972	Y-12 Rainfall (inches)	pH At Weir	Depth (inches)	Flow (gpm)	Nitrates (µg/g)	Nitrates (lbs/day)	Uranium (µg/g)
1	-	4.4	3.5	50.0	1,931	1,159	-
2	-	4.2	1.8	10.0	3,632	436	-
3	-	4.1	1.6	8.4	3,725	375	-
4	1.41	4.1	1.5	7.0	3,800	319	18.0
5	-	5.9	5.0	120.0	452	651	-
6	-	4.8	2.0	12.0	2,000	288	-
7	-	4.4	2.0	12.0	2,500	360	1.2
8	-	4.2	2.0	12.0	3,000	432	-
9	-	4.2	1.8	10.0	3,831	460	-
10	-	4.1	1.3	5.0	4,454	267	-
11	-	4.1	1.0	2.8	4,600	185	-
12	0.03	4.1	1.0	2.8	5,977	241	-
13	0.89	6.1	5.5	150.0	1,992	3,586	-
14	-	4.4	2.6	24.0	1,490	429	-
15	-	4.3	2.0	12.0	1,808	260	-
16	0.14	4.2	1.8	10.0	2,952	354	-
17	1.72	6.5	7.5	340.0	172	706	-
18	1.27	4.7	4.0	70.0	1,624	1,364	-
19	0.66	6.4	8.0	400.0	212	1,018	-
20	-	5.7	3.6	54.0	929	602	-
21	-	5.4	3.0	35.0	1,355	569	-
22	-	5.3	2.6	24.0	1,641	473	-
23	0.15	5.3	2.2	15.0	1,800	324	-
24	-	5.5	2.5	22.0	1,887	498	-
25	-	5.3	2.2	15.0	2,071	373	-
26	-	5.3	2.0	12.0	2,115	305	-
27	0.47	5.0	2.0	12.0	2,586	372	-
28	0.06	6.3	4.0	70.0	1,269	1,066	-
29	-	4.8	2.5	22.0	1,894	500	-
30	0.01	4.6	2.0	12.0	2,495	359	-
31	0.10	4.5	2.5	22.0	3,120	824	-
Total/mo.	6.91					19,155	

TABLE III

S-3 DISPOSAL POND SOLUTION ELEVATIONS BY MONTHS

Date	Pond (Elevation-Feet)			
	NE	SE	NW	SW
July 21, 1971	1013.8	1011.7	1013.3	1011.2
August 12, 1971	1014.0	1011.9	1013.7	1011.5
September 3, 1971	1013.6	1011.4	1012.7	1011.0
October 12, 1971	1013.8	1011.3	1012.2	1010.5
November 9, 1971	1013.8	1011.1	1012.0	1010.2
December 14, 1971	1013.8	1011.0	1012.6	1010.3
January 7, 1972	1013.9	1011.5	1013.6	1010.8
February 10, 1972	1013.8	1011.7	1013.8	1011.2
March 8, 1972	1014.4	1012.0	1014.2	1011.7
April 4, 1972	1014.4	1012.0	1014.2	1012.0
May 2, 1972	1013.8	1012.0	1013.8	1012.0
June 5, 1972	1013.7	1011.7	1013.7	1012.2
July 5, 1972	1013.9	1011.4	1013.5	1011.7
August 2, 1972	1014.0	1011.3	1013.3	1011.3
September 5, 1972	1014.0	1011.0	1012.7	1010.9
October 4, 1972	1013.9	1010.8	1012.7	1010.5
November 2, 1972	1014.0	1011.2	1013.5	1010.9

TABLE IV

TOTAL NITRATES BY MONTHS IN BEAR CREEK AND POPLAR CREEK

Month	Rainfall	Total Lbs. NO_3	
		Poplar Creek	Bear Creek
July	8.76	11,000	13,257
August	2.36	10,517	18,672
September	2.84	9,189	4,166
October	2.01	11,113	4,687
November	1.94	14,694	5,363
December	6.12	11,460	19,053
January	7.15	16,909	29,120
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May	5.15	14,984	22,947
June	4.03	15,701	12,534
July	4.72	13,147	12,376
August	2.31	12,651	19,191
September	3.39	11,825	5,029
October	6.91	13,211	19,155

These data are representative of only two of the nitrate sources sampled. They are not meant to include all contributing sources to either creek.

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

October 6, 1972

To: H. C. Francke

From: W. F. Harris WFH

Subject: Summary of nitrogen concentrations in soil water collected at 2' depth on forest irrigation plots

Nitrogen analyses included separate analysis of nitrate, ammonia, and total nitrogen (Table 1). Total nitrogen includes ammonia and organic nitrogen, but not NO_3-N. Analyses were processed with similar samples from on-going research on Walker Branch Watershed (WBW) by ESD personnel.

As anticipated, free soil water availability during the 6 June to 24 August period has been sporadic (Table 1). It is reasonable to assume, therefore, that NO_3 added during irrigation has remained in the upper soil horizons and been subject to assimilatory denitrification by litter and soil microflora during periods of favorable litter moisture conditions. The applications of effluent coincided with generally dry soil conditions. Summer rainfall typically does not recharge soil moisture because of high evaporative demands.

Pre-irrigation nitrogen concentrations are similar to results obtained on Walker Branch Watershed. Concentrations vary seasonally and with forest type. Therefore, a greater range of forest conditions from WBW will be available for comparison with 1972 treatments.

The results from the lysimeter on plot #1 appear to be spurious. The data suggest that effluent may be running down the side of the lysimeter tube or the tube intersects an old root channel at depth. The NO_3 concentrations peak shortly after irrigation followed by a decline which suggests direct channelization of effluent. This lysimeter will be relocated before soil moisture recharge occurs.

Effluent application has not affected total -N concentrations. Apparently the natural buffer system of the soil is effectively neutralizing the alkaline effluent without loss of colloidal soil organic matter. Ammonia concentrations have been highly variable and the data do not indicate any consistent patterns. Nitrate -N concentrations also are variable, but appear to be within the range of control plot concentrations.

The soil water data collected to date indicate that:

1) there have been no adverse effects on the soil system from application of alkaline (pH 10+) effluent;

2) the residence time of effluent NO_3 in the biologically active upper soil horizons ranges thus far up to 100 days (6/27-10/5).

What little soil water percolating beneath 2' thus far has nitrate concentrations within limits of control plots. The responses following soil moisture recharge will be evaluated as planned. We should expect some elevation in NO_3 concentration initially for both treated and control area followed by a decrease due to dilution from the increased volume of water moving down the soil profile.

WFH/clh

cc: D. E. Reichle
G. S. Henderson
D. J. Nelson

Attachment (Table 1)

Table 1. Summary of nitrogen concentrations in soil water percolating to the 2' depth on forest irrigation plots. Data are expressed as ppm N.

		PLOT NUMBER															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			(200 lb/A)				(800 lb/A)				(500 lb/A)				(Control)		
DATE																	
6-6	TOTAL-N	-	0.95	-	1.73	-	0.85	0.67	-	-	-	-	-	-	-	-	-
	NO_3	-	0.03	-	0.03	-	0.09	0.04	-	-	-	-	-	-	-	-	-
	NH_4	-	0.30	-	0.41	-	0.56	0.68	-	-	-	-	-	-	-	-	-
6-15	TOTAL-N	-	0.89	0.60	-	0.56	-	0.50	-	-	-	-	-	-	-	-	-
	NO_3	-	0.04	0.04	-	0.02	-	0.03	-	-	-	-	-	-	-	-	-
	NH_4	-	0.35	0.41	-	0.55	-	1.55	-	-	-	-	-	-	-	-	-
6-22	TOTAL-N	-	-	1.04	-	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	-	-	0.56	-	-	-	-	-	-	-	-	-	-	-	-	-
6-27[a]	TOTAL-N	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	-	0.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-5	TOTAL-N	2.55	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	1.40	-	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	0.97	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
7-6	TOTAL-N	1.65	-	-	1.65	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	1.89	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	0.19	-	-	0.28	-	-	-	-	-	-	-	-	-	-	-	-

Table 1 (continued)

DATE		PLOT NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		(200 lb/A)				(800 lb/A)				(500 lb/A)				(Control)			
7-13	TOTAL-N	0.63	-	-	1.10	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	*	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	*	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-
7-20[b]	TOTAL-N	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
7-28	TOTAL-N	2.24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-31	TOTAL-N	-	-	-	0.49	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
8-3	TOTAL-N	0.25	-	-	0.32	-	0.76	-	-	-	-	-	-	0.37	-	0.47	0.58
	NO_3	0.04	-	-	0.08	-	0.04	-	-	-	-	-	-	0.01	-	0.01	0.04
	NH_4	0.0	-	-	0.007	-	0.0	-	-	-	-	-	-	0.023	-	*	*
8-10	TOTAL-N	0.19	-	-	0.38	-	0.71	-	-	-	-	-	0.79	0.71	-	0.71	0.59
	NO_3	7.5	-	-	0.07	-	0.02	-	-	-	-	-	0.04	0.14	-	0.14	0.06
	NH_4	*	-	-	*	-	*	-	-	-	-	-	*	*	-	*	*

Table 1 (continued)

DATE		PLOT NUMBER 1 (200 lb/A)	2 (200 lb/A)	3 (200 lb/A)	4 (200 lb/A)	5 (800 lb/A)	6 (800 lb/A)	7 (800 lb/A)	8 (800 lb/A)	9 (500 lb/A)	10 (500 lb/A)	11 (500 lb/A)	12 (500 lb/A)	13 (Control)	14 (Control)	15 (Control)	16 (Control)
8-17[c]	TOTAL-N	0.71	-	1.30	0.34	-	-	-	-	-	-	-	-	-	-	-	-
	NO_3	8.0	-	0.16	0.06	-	-	-	-	-	-	-	-	-	-	-	-
	NH_4	*	-	*	*	-	-	-	-	-	-	-	-	-	-	-	-
8-24[d]	TOTAL-N	1.47	-	-	0.61	-	0.60	-	-	-	-	-	0.73	0.60	-	0.33	0.22
	NO_3	2.38	-	-	0.47	-	0.18	-	-	-	-	-	0.23	0.21	-	0.13	0.12
	NH_4	0.48	-	-	0.20	-	0.02	-	-	-	-	-	0.0	*	-	0.0	0.0

"-" indicates no water collected in lysimeter

"*" indicates insufficient volume of sample for analysis

[a]Date of first NO_3 application -- June 27, 1972

[b] te of second NO_3 application -- July 21, 1972

[c]Date of third NO_3 application -- August 24, 1972

[d]The soil profile has been free of percolating soil water from 8-24 to 10-5.

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

October 25, 1972

To: H. C. Francke

Subject: Results of Forest Irrigation Project: Organic Matter Losses from Forest Litter

Collections of forest floor litter were made prior to irrigation and ~ 3 weeks after the final treatment. The information to be gained from these data was two-fold: 1) litter comprises a significant pool of nitrogen and therefore is an essential component of a nitrogen budget and 2) if a significant amount of assimilatory denitrification occurred, litter organic matter (high energy carbon compounds) would represent the growth substrate and therefore a potential limiting factor to forest disposal.

Observations during the summer suggested that nitrate irrigation was accelerating decomposition. The data summarized in the attachment indicate approximately linear increases in percent organic matter loss for twig-branch and O_2 material (partially decomposed litter). The lack of response in decay of intact leaf material (O_1) is to be expected since most activity here is the result of microfauna. The percent loss data for O_1 material are corrected for the actual weight of the calcium nitrate added in irrigation. The gains in control and the 200 lb NO_3 A^{-1} treatment represent transfer from the O_1 to O_2 litter compartments. Twig-branch decomposition was increased by 75% with addition of 800 lb NO_3 A^{-1}. Assuming a forest litter pool composed of 2.8 t A^{-1} O_1, 4 t A^{-1} O_2 and 1 t A^{-1} twig-branch material, normal decay during the June-September interval would result in loss in 1.12 t A^{-1} O_1, a gain of 0.24 t A^{-1} O_2 and loss of 0.5 t A^{-1} twig-branch material or a net loss of organic matter of 1.38 t A^{-1}. The addition of 200 lb NO_3 A^{-1} did not affect total organic matter pool during this period (loss of 1.4 t A^{-1} with the slight increment due to accelerated loss of twig-branch litter). Addition of 500 lb NO_3 A^{-1} increased total litter depletion to 2.4 t A^{-1} (74% increase over controls and 200 lb NO_3 treatment). Addition of 800 lb NO_3 A^{-1} resulted in total depletion of 2.9 t A^{-1} (115% increase).

Annual litter input of organic matter (leaf fall, etc.) ranges from 4 to 6 t A^{-1} yr^{-1} and the forest litter compartment losses are in approximate equilibrium with this input--accumulation of litter is <u>slow</u> during a 500 year period of forest development. Our data are incomplete, but it is nonetheless apparent that substrate organic matter is the limiting resource to forest disposal. Extrapolation of observed decay to an annual basis, while extreme, serves to illustrate how organic matter acts as a limiting factor.

TREATMENT	Litter Organic Matter (t A^{-1}) / Est. Annual Decay (t A^{-1} yr^{-1})	Compartment Turnover Time (yr^{-1})
0	7.8/4.1 [1.]	1.91
200 lb NO_3	7.8/4.3	1.80
500 lb NO_3	7.8/7.2	1.08
800 lb NO_3	7.8/8.8	0.88

1.
Estimates of decay, pool size and turnover time are preliminary. Conversion to ash-free carbon equivalent will reduce these estimates of pool size and decay flux, but increase estimates of turnover time.

As annual decay increases, compartment turnover time decreases. An application rate of 500 lb NO_3 A^{-1} would result in complete removal of the forest litter in one year and would require an input of 7.2 t A^{-1} yr^{-1} (an amount greater than the forest vegetation can supply). An application of 200 lb NO_3 A^{-1} yr^{-1} is realistic (but certainly not the maximum rate possible). Turnover time is reduced 10% and total decay is within the range of expected litter input.

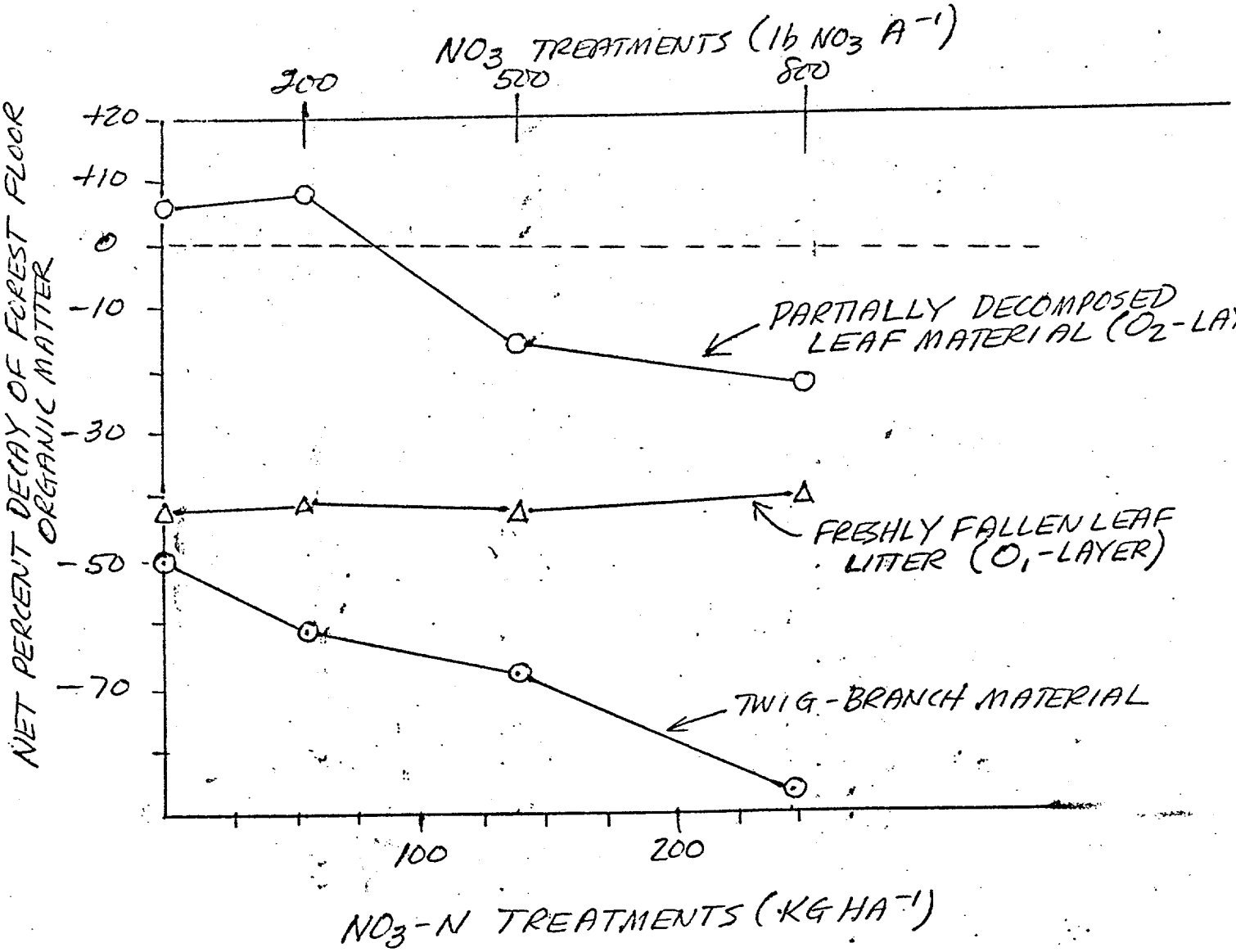
Forest disposal capacity is limited, but options are available to significantly increase disposal capacity if needed. Forest management operations (e.g. selective thinning) increase fallen branch material by at least an order of magnitude. Decay of this material responds rapidly to addition of nitrate (see attachment). Also, forest thinning can increase leaf production (20-30%) which eventually increases the amount of litter input available as substrate. The potential increases in disposal capacity available through coupled forest and waste management certainly merit our consideration in selection of disposal areas.

The data summarized thus far allow some comparison between agricultural and forest disposal. Our studies in other ESD projects indicate that forest soil microbial metabolism is only 0.10 as great as the metabolism of litter microbes. Agricultural systems lack a well developed litter layer; thus the two types of systems differ in assimilatory denitrification by as much as an order of magnitude. Accumulation of nitrogen in biomass is greater in the agricultural system. Intensive agricultural production ranges up to twice that of a forest (10 t A^{-1} yr^{-1} vs. 5-6 t A^{-1} yr^{-1}). Therefore, I would estimate that forested land is at least five times as effective as agricultural land for nitrate disposal. Loblolly pine stands can produce 10 t A^{-1} yr^{-1} which further increases the differential in disposal capacity. The nitrate losses from corn fields following application of 400 kg NO_3-N ha^{-1} described to us by Sopper et al. at Penn State would appear to be unavoidable.

W. F. Harris

Attachment

cc: C. W. Francis
G. S. Henderson
D. E. Reichle
D. J. Nelson



Decay of forest floor organic matter components following spray irrigation of nitrate salts. Values are percent change of O1 (corrected for direct addition of salts), O2 and twig-branch material from conditions prior to irrigation (measurements were made on June 6, 1972). Irrigation was performed incrementally commencing on June 27 with the final application on August 24. Litter collections post-irrigation were made on September 11 or 18 days following final irrigation. Therefore, the responses summarized should be viewed as transitory and subject to further measurement in June 1973, one full year post treatment.

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